

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



December 21, 2016

MATERIALS LABORATORY FACTUAL REPORT

Report No. 16-107

A. ACCIDENT INFORMATION

Place : Pascagoula, Florida
Date : August 27, 2106
Vehicle : Boeing 737-700
NTSB No. : DCA16FA217
Investigator : Pierre Scarfo, AS-40

B. COMPONENTS EXAMINED

Left winglet (2 pieces), number 1 leading edge slat (1 piece), and inlet cowling (5 pieces).

C. DETAILS OF THE EXAMINATION

An overall view of the submitted components is shown in figure 1. The left winglet was fractured into two pieces with the upper and lower pieces indicated in figure 1. The winglet was deformed and showed sliding contact marks adjacent to the fracture and at the leading edge near the upper end of the upper piece. The number 1 leading edge slat piece had cut edges on all sides and showed sliding contact marks with associated inward deformation of the panel. The fractured and deformed inlet cowling pieces were received in bags labeled to indicate they were recovered from the winglet and from the aft drain mast.

A view of the inboard side of the fractured end of the upper winglet piece is shown in figure 2. Surfaces adjacent to the fracture were generally deformed outboard and aft. Portions of the surfaces adjacent to the fracture had disturbed surface features with linear marks consistent with sliding contact with another object. An area with substantial deformation and relatively strong sliding marks was cut from the rest of the winglet piece for examination using a scanning electron microscope (SEM) and energy dispersive x-ray spectroscopy (EDS). The area of the winglet so examined is indicated with an unlabeled arrow in figure 2.

The surface of the winglet in the areas of sliding contact had a smeared appearance with linear features. A typical SEM image from the area of sliding contact is shown in the upper image in figure 3. The surface was examined in the as-received condition and was not cleaned with solvents prior to examination. Many particles were observed on the surface including particles with high peaks of sodium and chlorine.

The EDS spectrum for the sliding area shown in figure 3 is presented in the upper image in figure 4. The spectrum showed peaks of aluminum, copper, magnesium, and zinc consistent with a 7000-series aluminum alloy. Additional observed peaks consisted of carbon, oxygen, silicon, sulfur, chlorine, calcium, titanium, and chromium. Several particles on the surface had a typical spectrum such as the middle image in figure 4, where a high peak of titanium was observed. Two particles with high peaks of titanium are indicated in figure 3. The particles appeared relatively bright when viewed using backscattered electrons¹ (see the lower image in figure 3), consistent with a relatively higher atomic weight than the surrounding material consisting of an aluminum alloy. Multiple particles such as these were observed on multiple sites examined within the region of sliding contact.

A typical EDS spectrum for areas outside of the sliding contact damage area is shown in the lower image in figure 4. The surface showed peaks of aluminum, oxygen, zinc, sulfur, chlorine, and carbon. No evidence of titanium was observed, and no particles with peaks of titanium were observed in the areas examined outside of the areas of sliding contact damage.

Green primer was present on the interior of the winglet, and an area of the primer was analyzed using EDS, resulting in the spectrum shown in figure 5. A titanium peak was detected associated with the primer, but higher peaks of silicon, magnesium, oxygen, and carbon were also present. No peaks of silicon, magnesium, or oxygen were detected in the typical spectrum for the particles indicated in figure 3.

A close view of the number 1 leading edge slat piece is shown in figure 6. Sliding contact damage was observed across most of the piece, but an area near the edge of the piece at the middle of the length appeared to have some of the deepest marks (see unlabeled arrow in figure 6). The piece was cut into 3 pieces to facilitate an SEM examination of the indicated area with analysis using EDS. The pieces were blown free of loose surface debris with compressed air after cutting. No other cleaning of the surface was completed prior to examination.

Typical spectra in areas of sliding contact damage and in areas outside of the contact damage are shown in figure 7. Both spectra showed similar spectra with elements consistent with a 7000-series aluminum alloy and smaller peaks of surface contaminants and deposits. No peak of titanium was observed in any of the areas examined on the slat piece.

¹ SEM images produced using a backscatter detector in composition mode have contrast that is associated with atomic weight of the elements in the image. Areas with elements having higher atomic weights appear as a relatively lighter shade of gray compared to areas having elements with lower atomic weights.

One of the inlet cowling pieces was placed in the SEM and examined using EDS in the as-received condition with no cutting or cleaning. EDS spectra for various areas of the inlet cowling piece are shown in figure 8. None of the spectra showed peaks of titanium.

Matthew R. Fox
Senior Materials Engineer

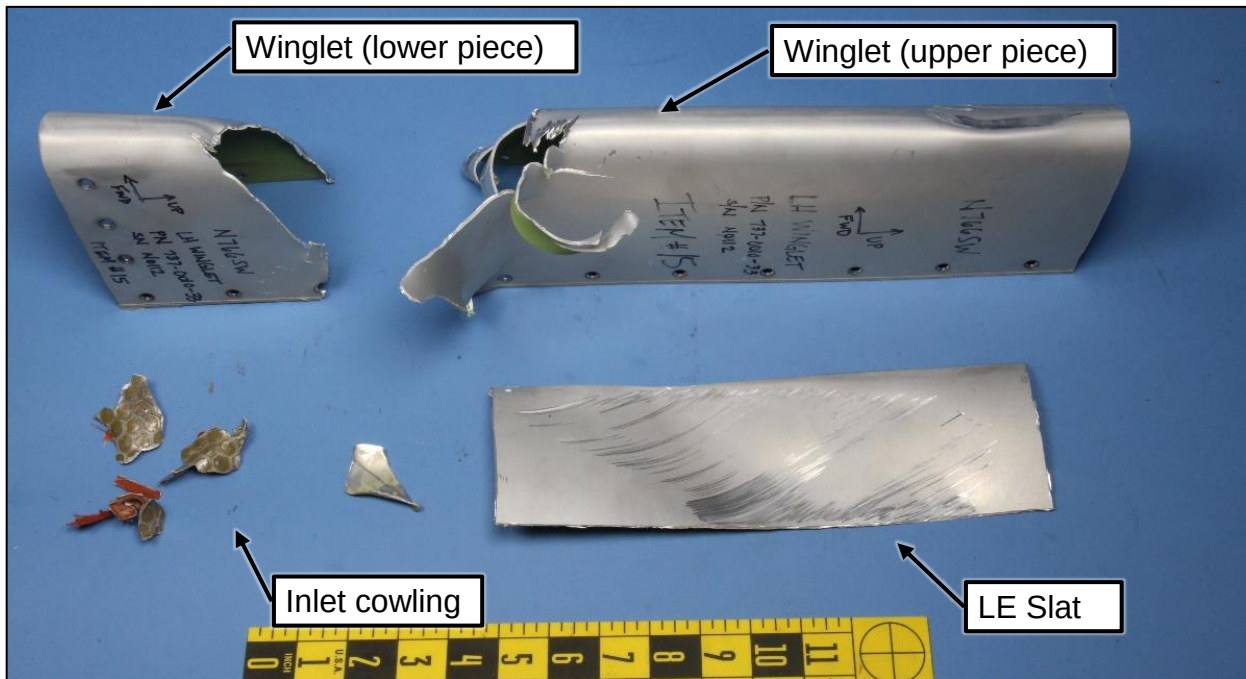


Figure 1. Overall view of the submitted components.

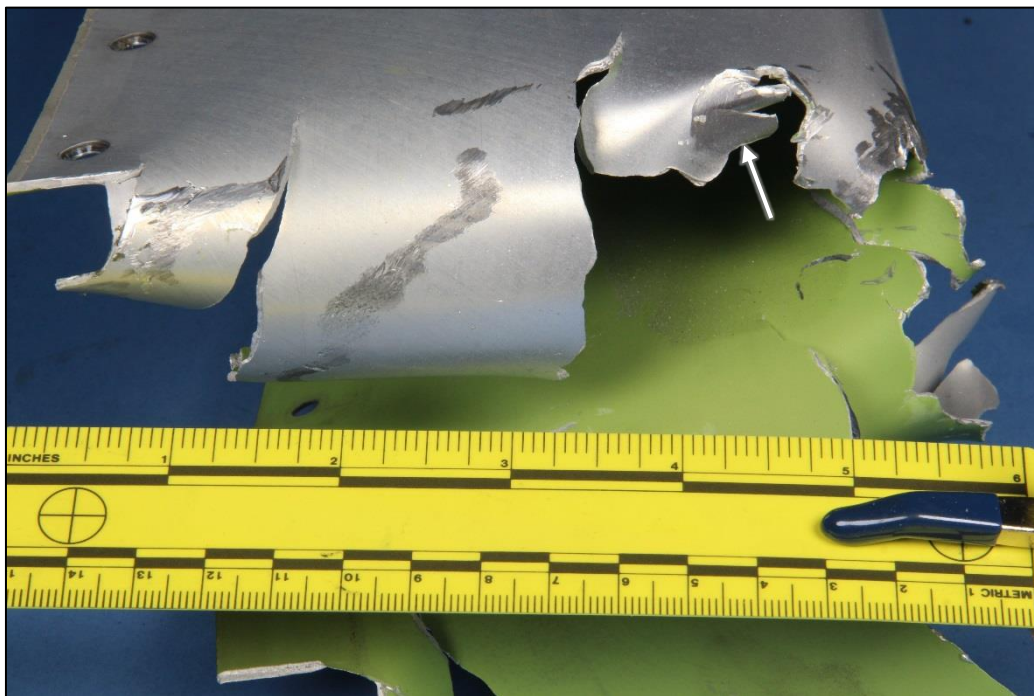


Figure 2. Fractured end of the winglet upper piece as viewed looking upward. An unlabeled arrow indicates the smeared area examined using SEM and EDS.

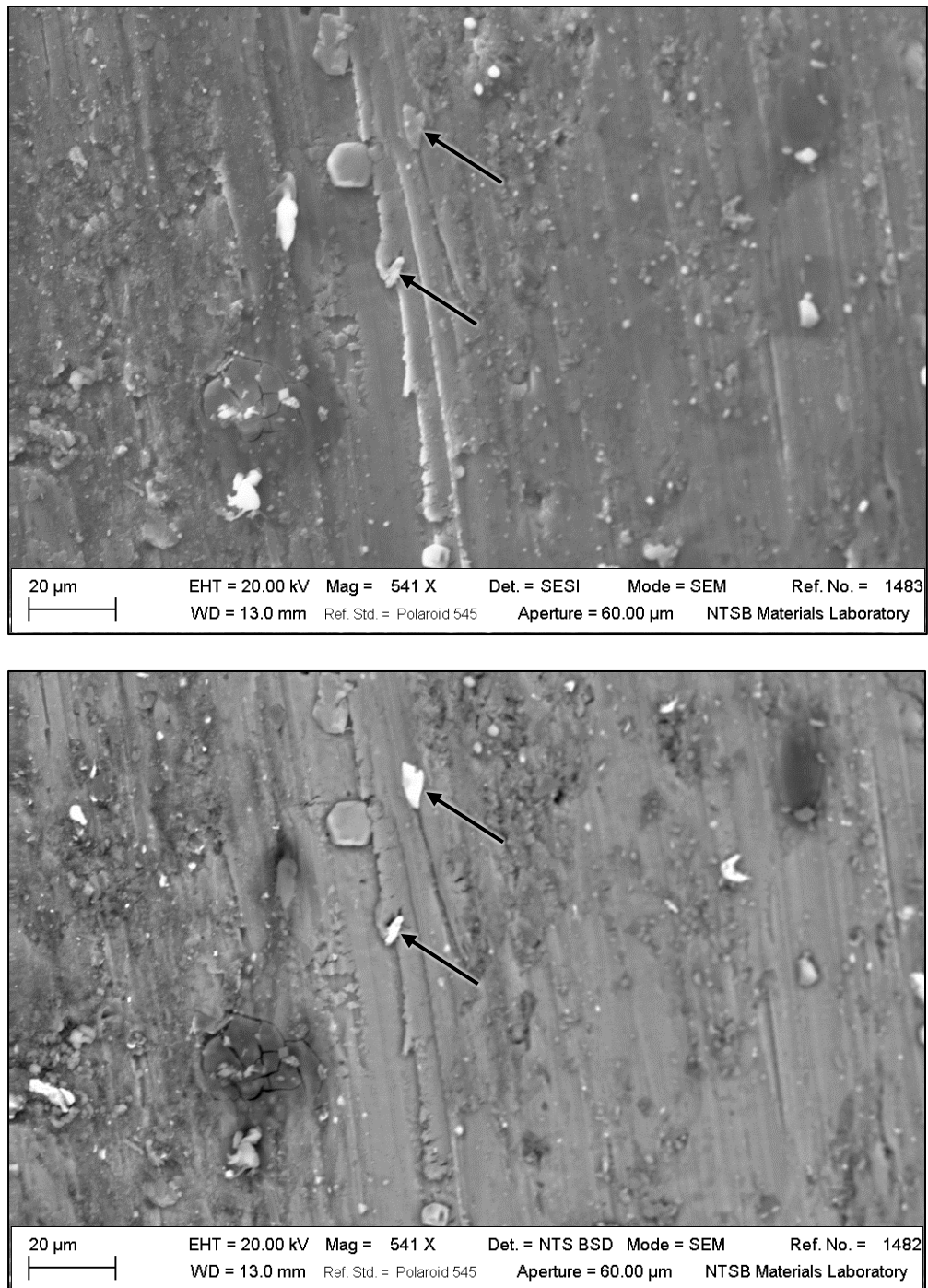


Figure 3. SEM images of a location showing evidence of sliding contact in the area indicated in figure 2 as viewed with secondary electrons (upper image) and backscattered electrons (lower image). Unlabeled arrows indicate particles with a high of titanium in the EDS spectrum (see figure 4).

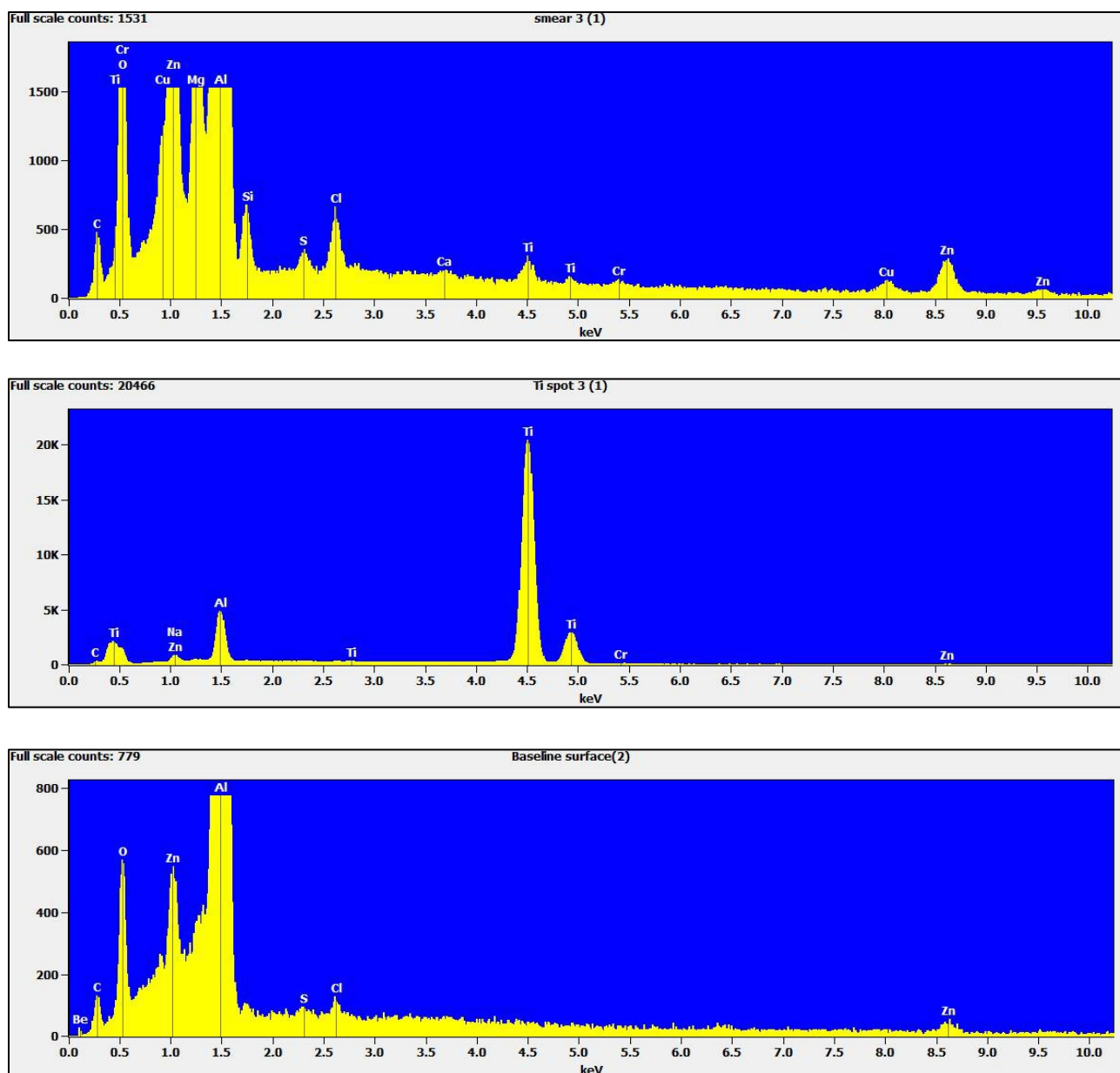


Figure 4. Typical EDS spectra for selected areas of the winglet. The upper image shows a spectrum associated with scanning a beam across the area of sliding contact shown in figure 3. The middle spectrum is a spectrum obtained with a spot beam centered on one of the particles indicated with unlabeled arrows in figure 3. The lower image shows a typical EDS spectrum for the surface of the winglet in areas that appeared to be free of sliding contact damage.

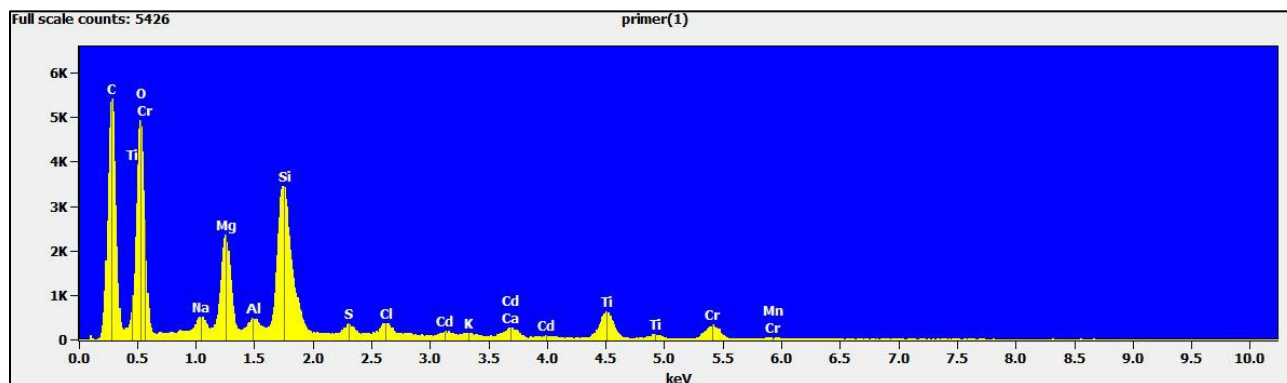


Figure 5. EDS spectrum obtained scanning a beam across the green primer on a piece of the winglet.

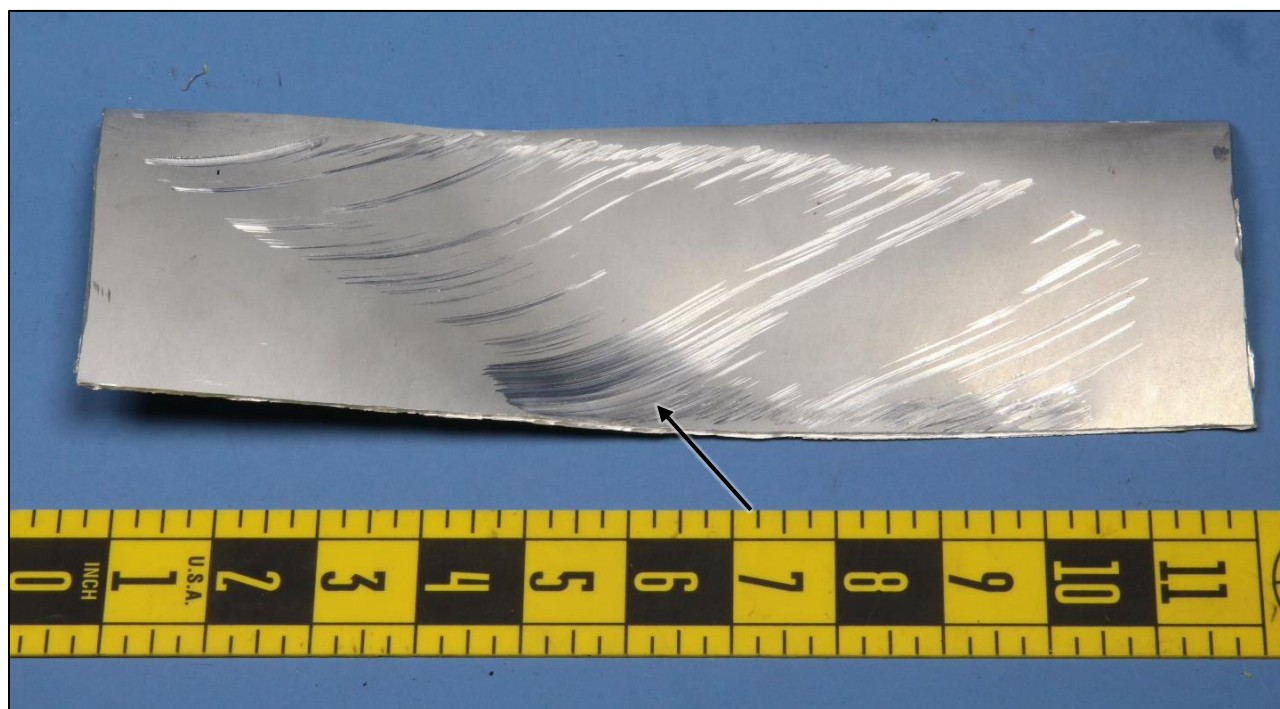


Figure 6. Close view of the number 1 leading edge slat. An unlabeled arrow indicates the area examined by SEM and EDS.

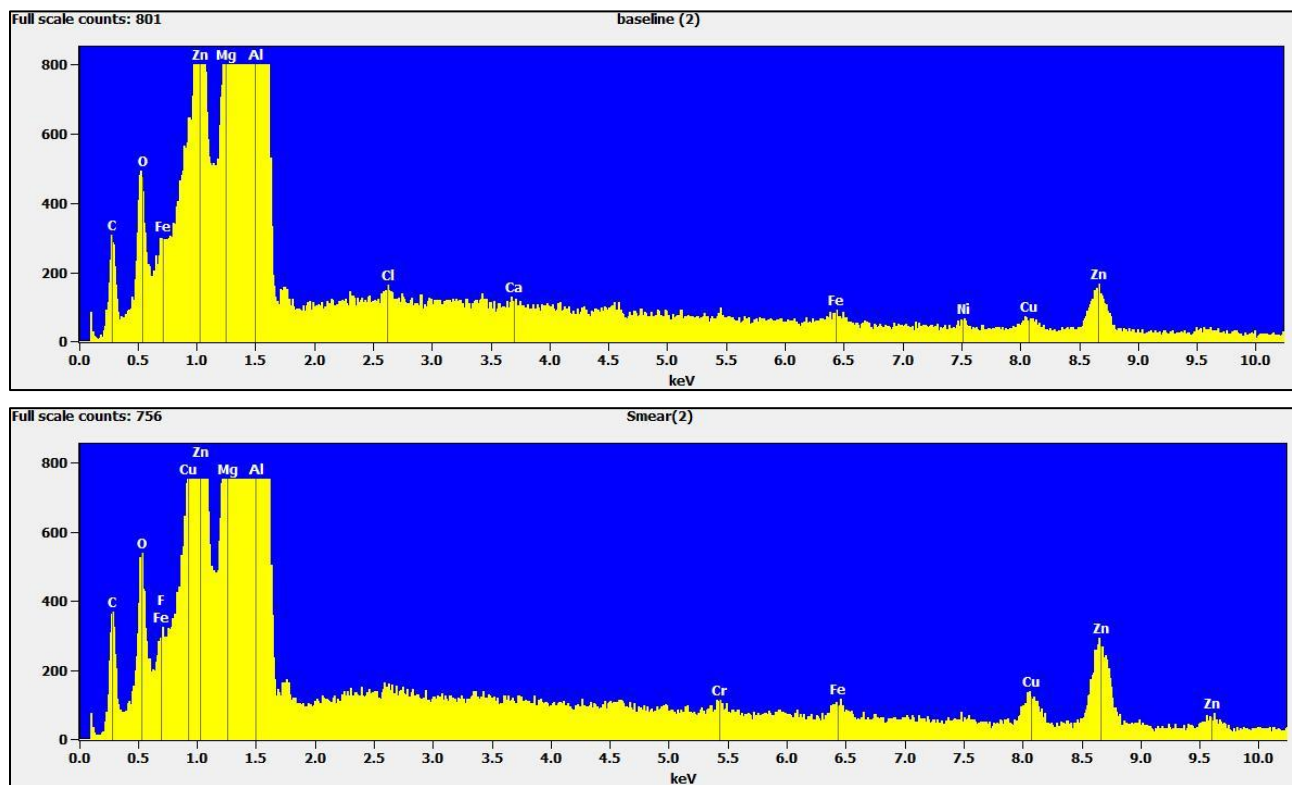


Figure 7. EDS spectra for areas of the number 1 leading edge slat showing a typical spectrum from an area free of sliding contact marks (upper image) and from within an area of sliding contact marks (lower image).

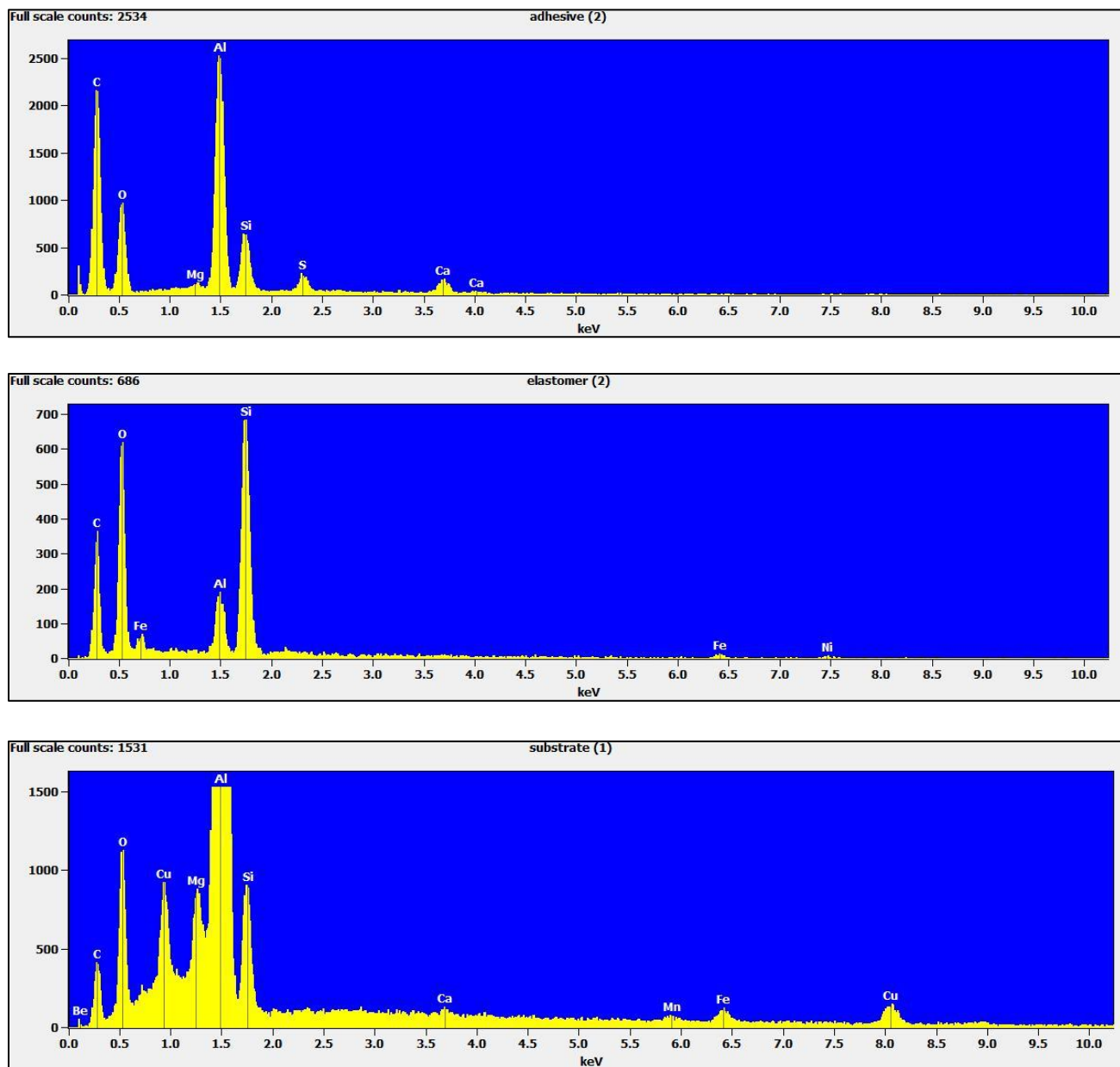


Figure 8. EDS spectra from areas of an inlet cowling piece showing resin areas between honeycomb walls (upper image), red elastomer (middle image), and the metal substrate in areas where the red elastomer was pulled away from the surface (lower image).